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(54) SME controlled valve

(57) A pressure cooker has a temperature responsive device controlled by an operating member of shape memory effect (SME) material 26. The device may be a pressure regulator valve, an air vent valve or a pressure relief valve.

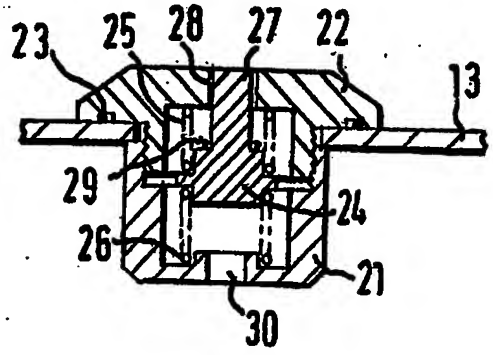

FIG. 2a

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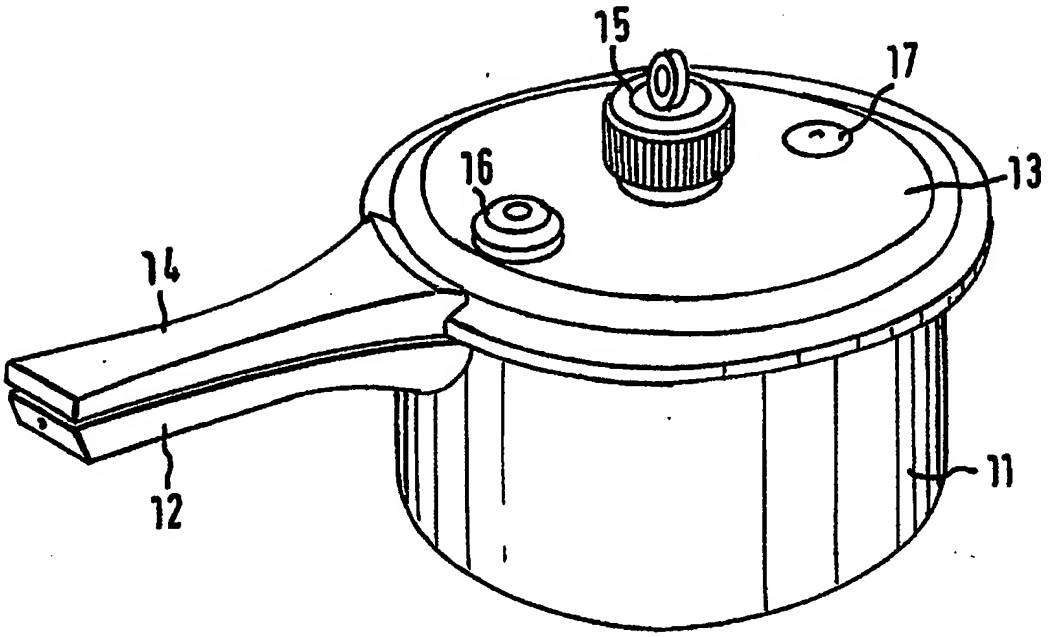

FIG.1

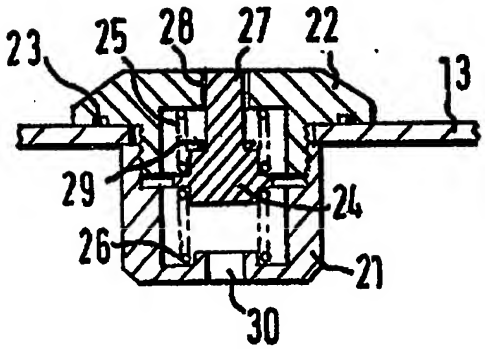

FIG.2a

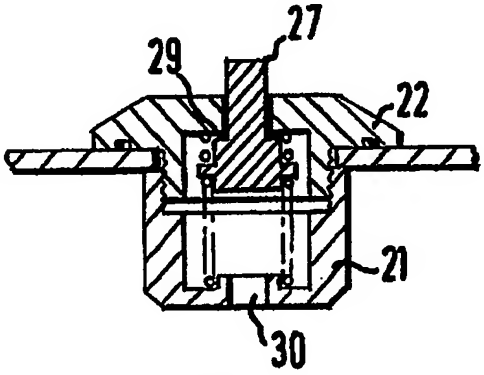

FIG.2b

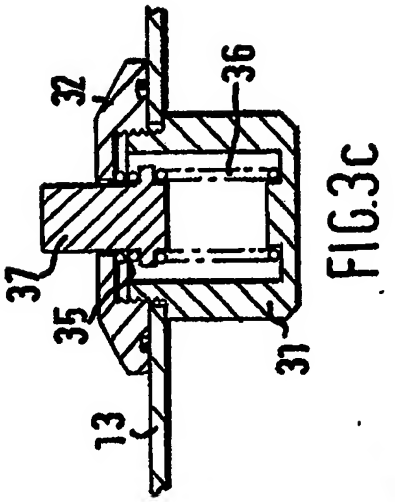

FIG.3c

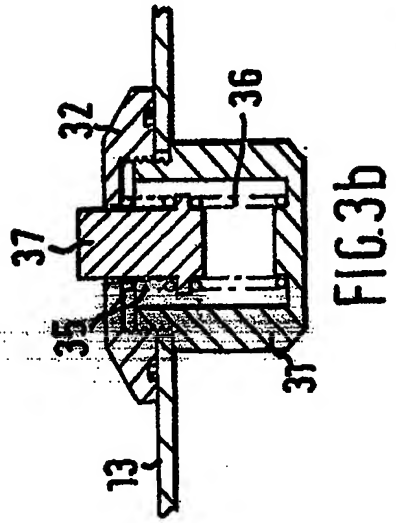

FIG.3b

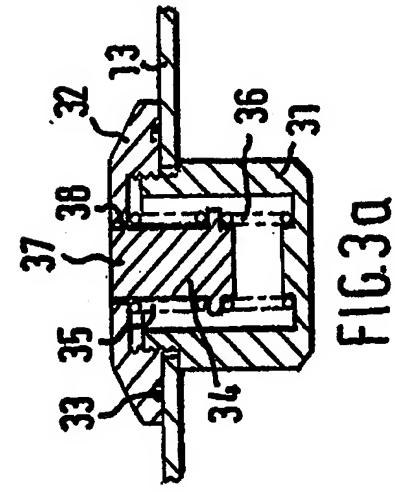

FIG.3a

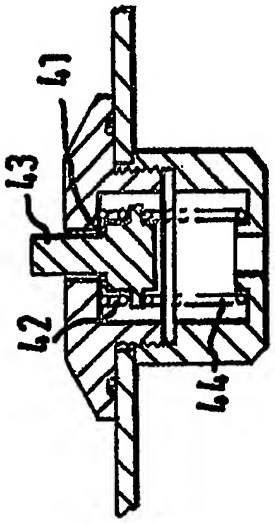

FIG.4a

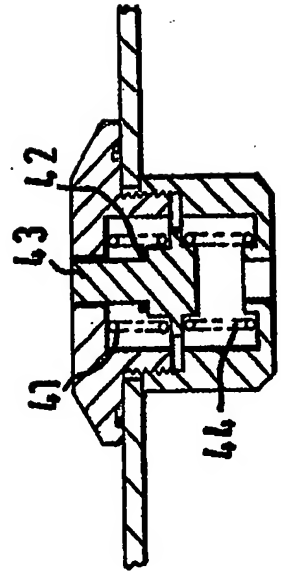

FIG.4b

SPECIFICATION

Improvements in or relating to pressure cookers

This invention relates to pressure vessels and particularly, though not exclusively, to pressure vessels used for domestic cooking.

Domestic pressure cookers place the food to be cooked under low pressure in a steam environment. Cooking times are substantially reduced over conventional cooking vessels resulting in a time and energy saving for the user.

Within the pressure cooker it is desirable to displace as much air as possible by steam before the cooker is closed and pressure allowed to increase to the desired level. Excess air can act as an insulating blanket and prevent reliable determination of the cooking time. An air vent is usually provided in the pressure cooker lid and may be closed manually by the cook when the air has been displaced; issuance of steam from the vent is a reliable indication to the cook that most of the air has been displaced.

Alternatively the vent may be closed automatically and it has been proposed to utilise a device responsive to turbulence in the pressure cooker. The device is located in the air vent aperture and moves up and down in response to increasing turbulence until a sealing portion of the device is brought into contact with the pressure cooker lid. The steam pressure inside the vessel holds the device in place to close the air vent aperture and allow pressure to rapidly increase. Such devices cannot act precisely since they are neither responsive to temperature or pressure but to turbulence. As a result they may close the air vent at any temperature in the range 95°C—100°C dependent on the quantity of food and water within the vessel. Other devices have been proposed which are both complicated and expensive.

In one aspect the present invention seeks to provide means to precisely close a pressure cooker air vent at the desired temperature regardless of the contents of the vessel and which are simple, reliable and economical to manufacture.

A regulator valve is provided in the pressure cooker to limit steam pressure to a desired level. In one popular type of pressure cooker the regulator valve comprises a vent closed by a weighted needle valve, excess pressure raising the needle valve from its seat to allow steam to issue. The weight may be chosen to suit a desired cooking pressure.

When the pressure cooker has reached the desired operating pressure it is good practice to reduce the heat input to avoid repeated venting of excess steam. With practice the user can select a low heat input which is sufficient to maintain the pressure cooker at a temperature just below that which will result in excess steam venting. Automatic means for reducing the heat input to the cooker have been proposed but they are expensive and increase the complication of the pressure cooker. Visual temperature indication means have also been proposed to indicate to the user the point at which the heat input may be reduced. It is desirable that such indicators operate in discrete stages to avoid uncertainty in the mind of the user which may occur with a progressive device such as a spring loaded plunger responsive to pressure within the cooker.

In another aspect the present invention seeks to provide an improved temperature indicator which gives a step change indication of a desired temperature within the pressure cooker and which is simple, reliable and economical to manufacture.

According to the present invention there is provided a temperature responsive device of a steam pressure vessel and comprising a hollow housing having an aperture for communication to the exterior of the vessel, a response member movable in the housing from a first position to a second position, a return bias acting between the housing and the response member to urge the response member to said first position and an operating member of SME alloy acting on the response member in opposition to said return bias and having a temperature transition range encompassing the response temperature.

Such an indicating device is especially adapted for steam pressure vessels because of the relationship between steam pressure and steam temperature.

By an SME alloy is meant an alloy which exhibits shape memory effect (SME). SME materials are well known and are distinguished by having elastic moduli which vary significantly with temperature, in a reversible manner, over a transition temperature range which is dependent on the composition of the material. The alloy undergoes a martensitic transformation during change of temperature through the transition range. One SME alloy is a copper-zinc-aluminium alloy, the proportions of the constituents being varied to obtain a desired transition temperature range.

The use of SME devices is shown for example in published British Patent Applications 2,023,818 and 2,043,764. The SME device and said return bias may be in the form of wire coil springs.

Preferably said response member is movable from a first position within the housing to a second position inn which said member protrudes through the aperture.

In one embodiment the indicating member comprises a stepped cylindrical plunger having a shoulder to provide location for said springs, one each on either side of the shoulder.

As previously indicated it is desirable to automate closure of the air vent to ensure a reliable determination of the start of the cooking period. This will avoid the need for venting of excess steam and air via the regulator valve and permit so called "silent cooking".

According to this aspect of the invention there is provided a vent hole in the housing to provide communication from said aperture to the interior

of a pressure cooker, said indicating member being provided with sealing means to close communication between the vent hole and aperture at said second position.

Such a device will give precise closure of an air vent at a specified desired temperature, for example 98°C, regardless of the contents of the cooker. More effective air venting will be possible giving more consistent results for the cook.

Preferably said sealing means comprises a flexible O-ring located on a shoulder of said indicating member.

Some pressure cookers incorporate safety vents to ensure that should pressure and/or temperature within the pressure cooker exceed a safe level, the vent opens. A further aspect of the invention provides a temperature responsive pressure relief valve incorporating an SME spring responsive to an excessive temperature level with a pressure cooker such that at the excessive temperature level the SME spring undergoes transformation to open the vent. The transformation temperature of such a spring may be in the range 130°C—140°C. Such a high steam temperature is associated with high pressure and the relief valve will thus act as a pressure relief valve.

Three embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:—

Figure 1 is a general view of a domestic pressure cooker;

Figures 2a and 2b show an air vent valve according to one aspect of the invention and in the open and closed positions;

Figures 3a, 3b and 3c show a temperature indicator according to another aspect of the invention and in the three operational positions; and

Figures 4a and 4b show a pressure relief valve according to a third aspect of the invention and in the open and closed positions.

With reference to the drawings there is shown a domestic pressure cooker comprising a base 11 having a handle 12 and an interlocking lid 13 having a handle 14. The handles 12 and 14 coincide, as shown, when the lid is interlocked to the base.

The lid 13 includes a weight valve 15, an automatic vent valve 16 and a safety valve 17.

Figure 2a shows an air vent valve in the open position. The valve comprises a body 21 held against the inside of an aperture through the cooker lid 13 by a co-operating screw-threaded cap 22. An O-ring 23 seals the cap 22 to the lid 13.

A plunger 24 is held and guided within the body 21 by co-operating opposed coil springs 25 and 26 and has a cylindrical extension 27 which passes through a central aperture 28 in the cap 22, an O-ring 29 is provided at the base of the extension 27. A small clearance is provided between the extension 27 and the aperture 28. An aperture 30 is provided in the base of the body 21.

The coil spring 26 is of shape memory effect metal and has an alloy composition chosen to ensure rapid upward movement of the plunger 24 at a temperature corresponding to emission of steam from the pressure cooker. Spring 25 is a return spring against which the SME spring 26 can work; alternatively a suitable mass could provide a bias.

In operation the vent valve allows air to pass from the pressure cooker through aperture 30 and the clearance between the cap 22 and the plunger extension 27. In the open position, as shown in Figure 2a, the top of the extension 27 is flush with the cap 22.

As steam begins to pass through the aperture 30 the SME spring is rapidly heated and undergoes transformation to raise the plunger 24 against the effect of spring 25. O-ring 29 closes the clearance between the extension and cap so sealing the pressure cooker. The transformation temperature for the SME spring is precisely chosen at a point in the range 95°C—100°C.

The pressure cooker is thus automatically sealed for operation and the extension 27 protrudes through the cap 22 to indicate to the user that the vent valve has closed. Increasing pressure within the cooker will positively urge the plunger 24 against the cap 22 to ensure that the extension 27 remains protruding whilst the cooker is under pressure.

Thus the protruding extension 27 serves both to indicate to the user that the air vent has closed, and to indicate that the contents of the cooker are hot and/or under pressure.

The cooking time may be determined by an automatic timer or other known means. When the cooker is removed from the heat source the contents will cool and the SME spring contract at the transformation temperature. The plunger 24 will only return to the position of Figure 2a, however, when the pressure inside the cooker has dropped to a low value, for example below 0,04 bar. Thus the indicator acts in addition to other safety devices to indicate to the user when it is safe to open the cooker.

A further advantage of such an indicator is that it will "fail safe", i.e. in the warning position.

The indicator may be tested by pressing the plunger downwards, if the contents of the cooker are above the transition temperature the SME spring will return the plunger to the closed position to re-seal the cooker. The device therefore also provides a useful "press to test" facility.

As shown in Figure 1 a separate weight valve 15 is provided to regulate the pressure level within the cooker. It is to be understood however that the weight valve 15 and automatic vent valve 16 could be incorporated into the same assembly.

With reference to Figure 3a there is shown a temperature indicator comprising a body 31 held against the inside of a pressure cooker lid 13 by a screw threaded cap 32. An O-ring 33 seals the cap to the lid.

As in the previous embodiment a plunger 34 is located and guided by coil springs 35 and 36.

Spring 35 is a return spring and spring 36 is of SME material. The plunger has a cylindrical extension 37 protruding through an aperture 38 of the cap 32.

In operation, venting of air and steam is through a separate passage, for example the central aperture of the cooker lid 13 shown in Figure 1. The SME spring is heated by conduction and radiation through the wall of the body 31; the transformation temperature of the SME material is chosen to correspond to a desired lower cooking temperature which is less than that corresponding to the issuance of steam through the pressure regulator valve. The SME spring expands rapidly at transformation temperature to the position shown in Figure 3b. This position indicates to the user that the heat input may be reduced. The portion of the extension 37 protruding through the cap 32 may be coloured orange, for example, to indicate this state.

Further increase of temperature will result in progressive further expansion of the SME spring 36 until the position of Figure 3c is reached. The cooker is now under pressure and at a desired upper cooking temperature but still less than that corresponding to the issuance of steam through the regulator valve; the additional band of extension 37 now showing may be coloured red, for example, to indicate that the heat input may be further reduced.

If the user regulates the heat input between the desired lower and upper cooking temperatures, so called "silent cooking" will be achieved since there will be no emission of steam from the pressure regulator valve.

If a step change in protrusion of the extension 37 is required for the second stage of operation, the assembly could include a second SME spring having a higher transformation temperature corresponding to the desired upper cooking temperature of the pressure cooker. Alternatively the SME spring could be arranged to pick up an additional load, for example a dead weight or pre-loaded spring.

Although the body 31 is shown closed from the pressure cooker internal space for reasons of hygiene this is not essential. If it were open to the inside then means for retaining pressure within the cooker would need to be provided, for example, by seal between the extension 37 and the cap 32.

The position of the indicator plunger of Figure 3 may be utilised to control the heat source directly to avoid excessive venting of steam; and in conjunction with a timer to give fully automatic silent cooking.

With reference to Figures 4a and 4b there is shown a temperature responsive pressure relief valve. The valve illustrated is similar in construction to the valve of Figure 2 but has the SME spring and bias spring interchanged.

In the closed position (Figure 4a) the SME spring 41 is contracted and the O-ring 42 prevents communication from the interior of the pressure vessel to the exterior. At a precise desired temperature, which for a pressure cooker may be chosen in the range 130°C—140°C, the SME spring expands rapidly against the bias spring 44 to move the plunger 43 downwards as viewed and vent the vessel interior (Figure 4b). The close relationship between temperature and pressure of steam ensures that the relief valve can open precisely at the specified pressure. SME material is ideally suited to operating such devices in a steam environment.

The invention is applicable to all steam pressure vessels in which actuation of a device is required at a pressure, actuation being by SME spring responsive to a temperature corresponding to that pressure.

Although the invention has been particularly described with reference to domestic pressure cookers, itt is equally applicable to pressure vessels used to sterilize articles under pressure by contact with steam. Such vessels are functionally and constructionally very similar to pressure cookers.

CLAIMS

1. A temperature responsive device of a steam pressure vessel and comprising a hollow housing having an aperture for communication to the exterior of the vessel, a response member movable in the housing from a first position to a second position, a return bias acting between the housing and the response member to urge the response member to said first position and an operating member of SME alloy acting on the response member in opposition to said return bias and having a temperature transition range encompassing the response temperature.

2. An actuator according to Claim 1, wherein the operating member is a coil spring made of SME alloy.

3. An actuator according to Claim 1 or Claim 2, wherein said response member is movable from the first position within the housing to a second position in which said member protrudes through the aperture.

4. An actuator according to any preceding claim, wherein said response member is movable to a third further position by temperature responsive means responsive to temperatures above the transition range of the SME alloy spring.

5. An actuator according to any preceding claim, wherein a vent hole is provided in the housing to provide communication from the interior of the vessel to the aperture, said response member being provided with sealing means to close communication between the vent hole and said aperture at one of said first and second positions.

6. An actuator according to Claim 5 wherein the sealing means close said aperture at the second position of the response member.

7. An actuator according to Claim 5 wherein the sealing means close said aperture at the first position of the response member.

8. A temperature responsive actuator

substantially as described herewith with reference to the accompanying figures 2a and 2b.

9. A temperature responsive actuator substantially as described herein with reference to the accompanying Figures 3a, 3b and 3c.

10. A temperature responsive actuator substantially as described herewith with reference to the accompanying Figures 4a and 4b.

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